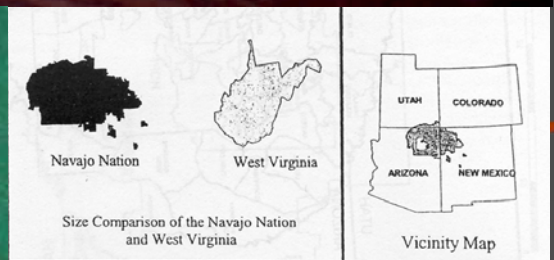
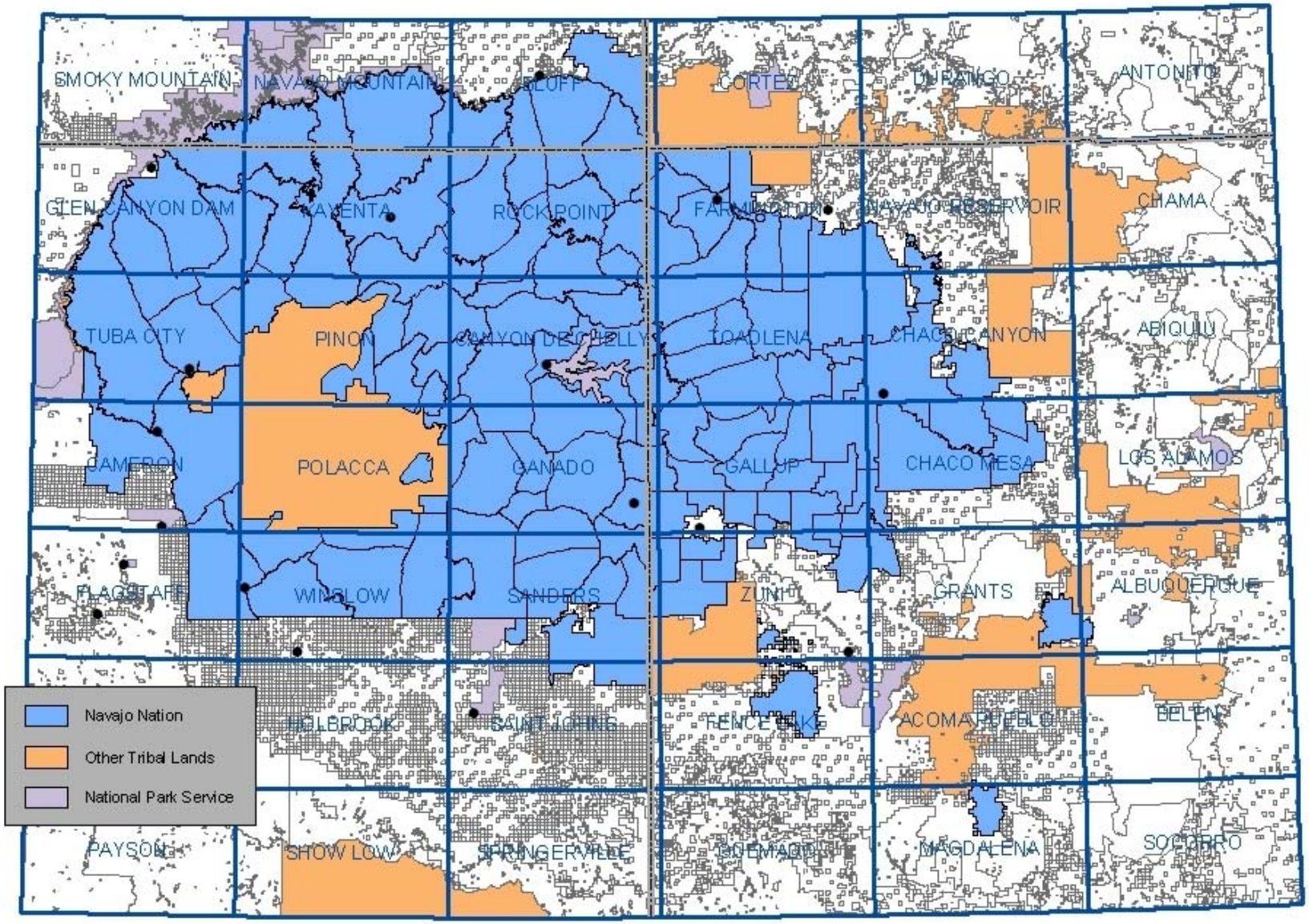
Navajo Nation

- 72,000 km^2
- 27,000 mi^2

USGS
science for a changing world



30' x 60' Quadrangles on the Navajo Nation

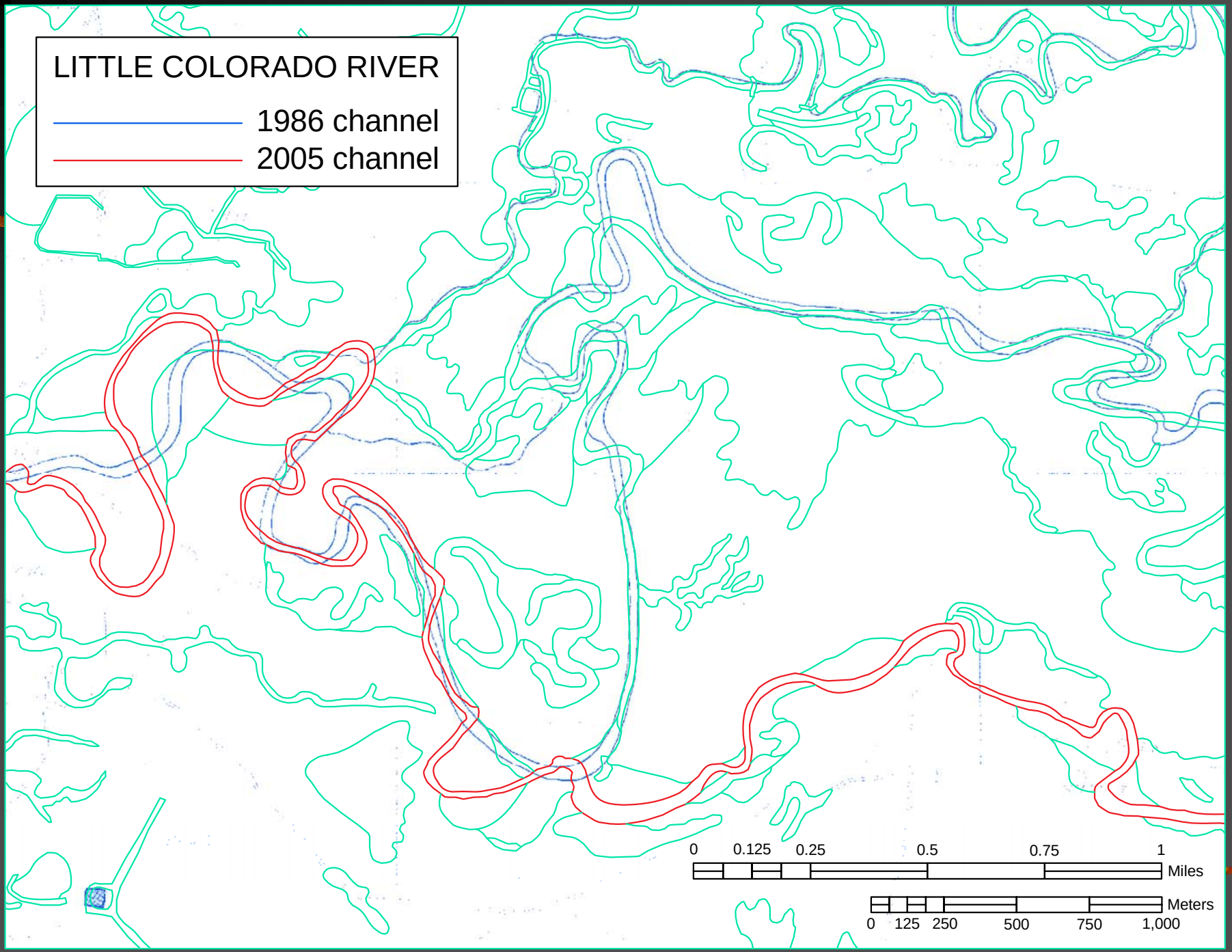


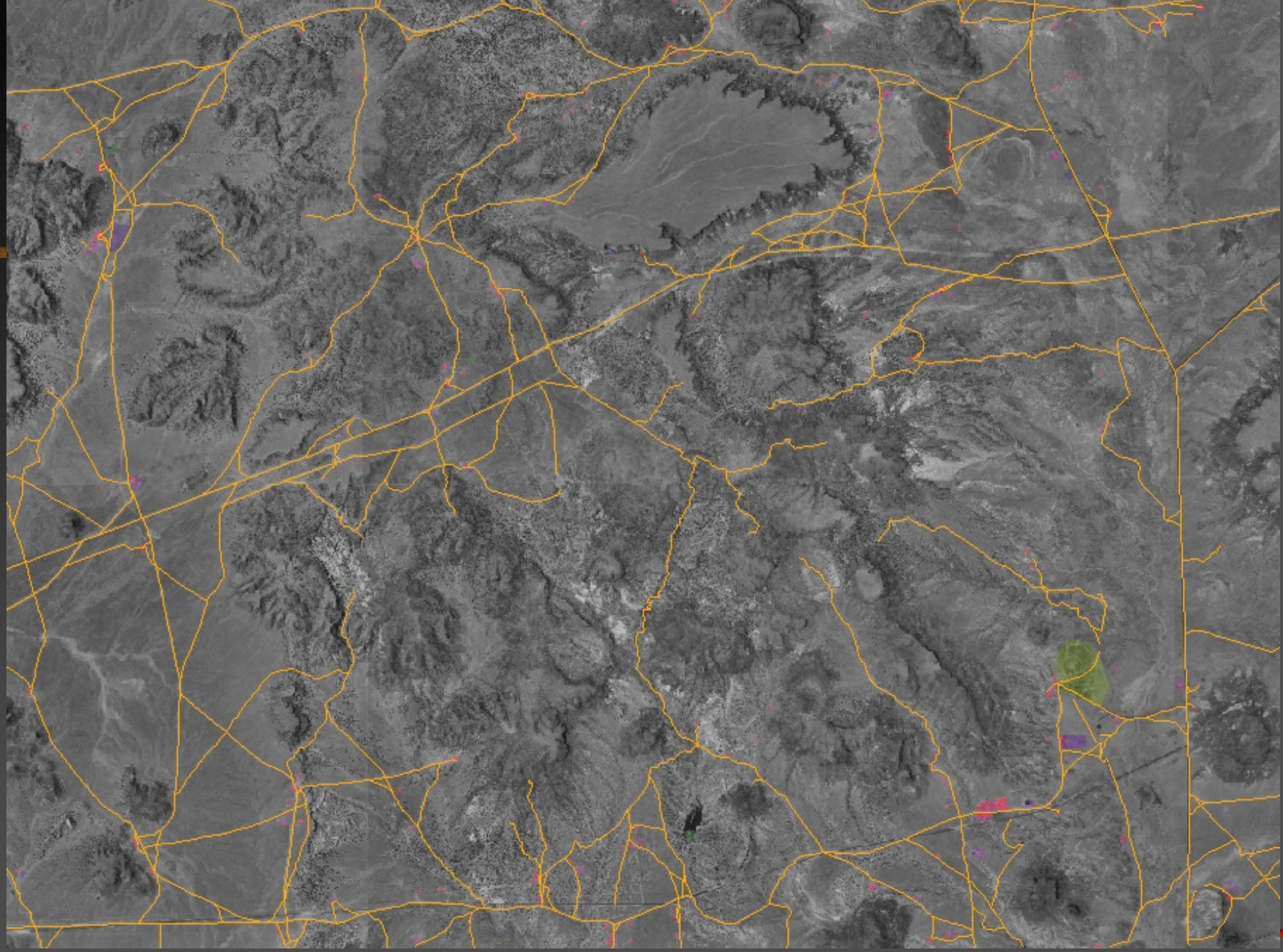
Objectives and Strategies

- ***Bedrock Mapping: Information for land use planning and urban development***
  - ***Structural stability of housing foundations***
  - ***Environmental impacts of landfills/septic systems***
  - ***Hydrologic Resources***
  - ***Landscape stability/surface erosion***

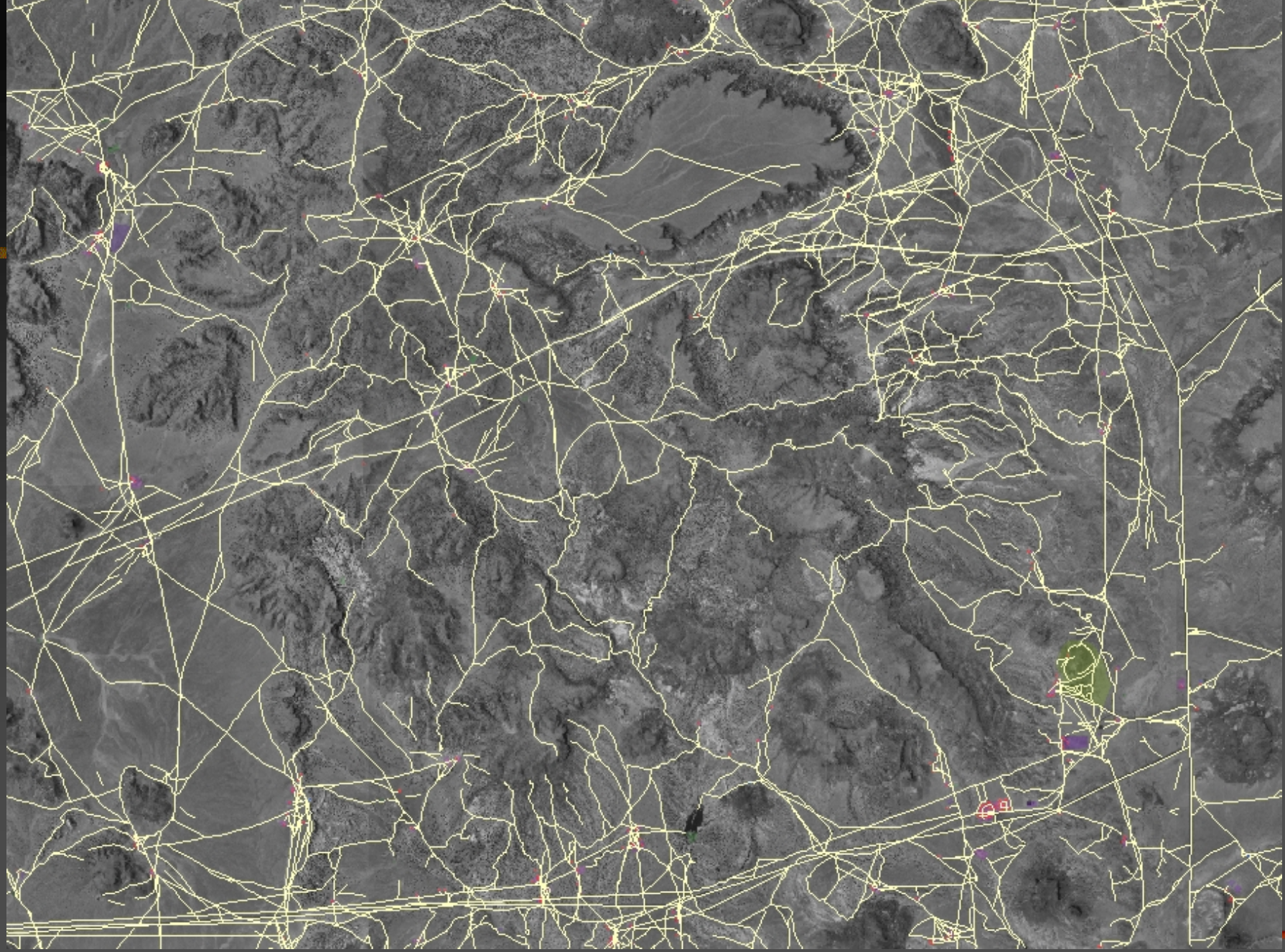
Objectives and Strategies

- ***Surficial Mapping:*** **Information for land use planning and urban development**
  - **Geologic Hazards**
  - **Landscape changes in response to land use and climate change**
  - **Drought mitigation**
  - **Surface Erosion / Vegetation**


LITTLE COLORADO RIVER
1986 channel
2005 channel
0
0.125
0.25
0.5
0.75
1
Miles
Meters
0
125
250
500
750
1,000



-Roads recorded on late 1960’s Topographic map.



-All visible roads from 1990’s DOQQs.

Land Surface Changes -Documentation

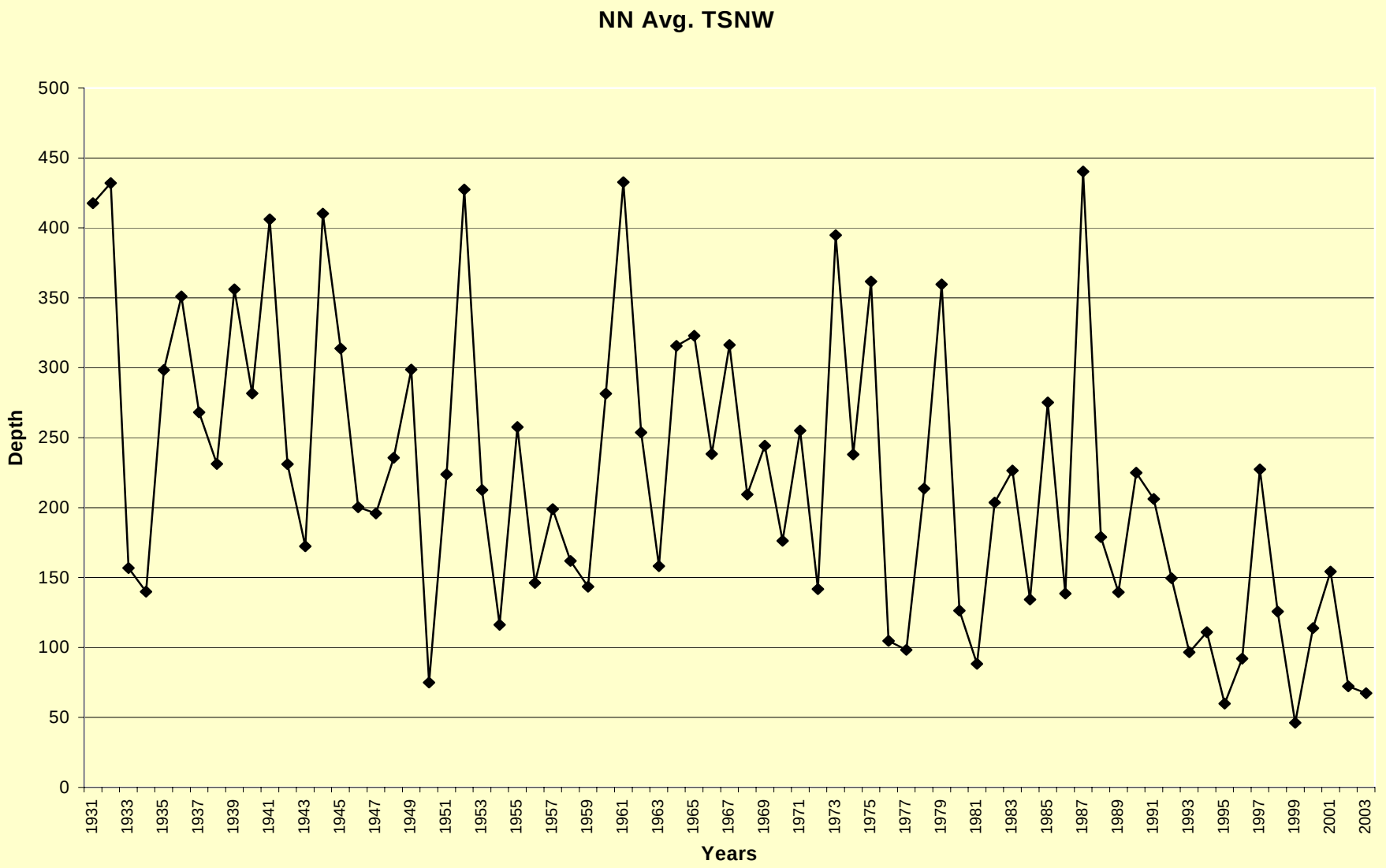
Temperature & Rainfall Changes predicted by High Resolution Regional Climate Model 2X CO_2

	Temperature ^{o}C	*Rainfall (mm/day)*
Winter	+ 4.0	-1.0
Spring	+4.0	0.0 to +0.5
Summer	+5.0	-0.5
Fall	+4.0	-0.5 to +0.5

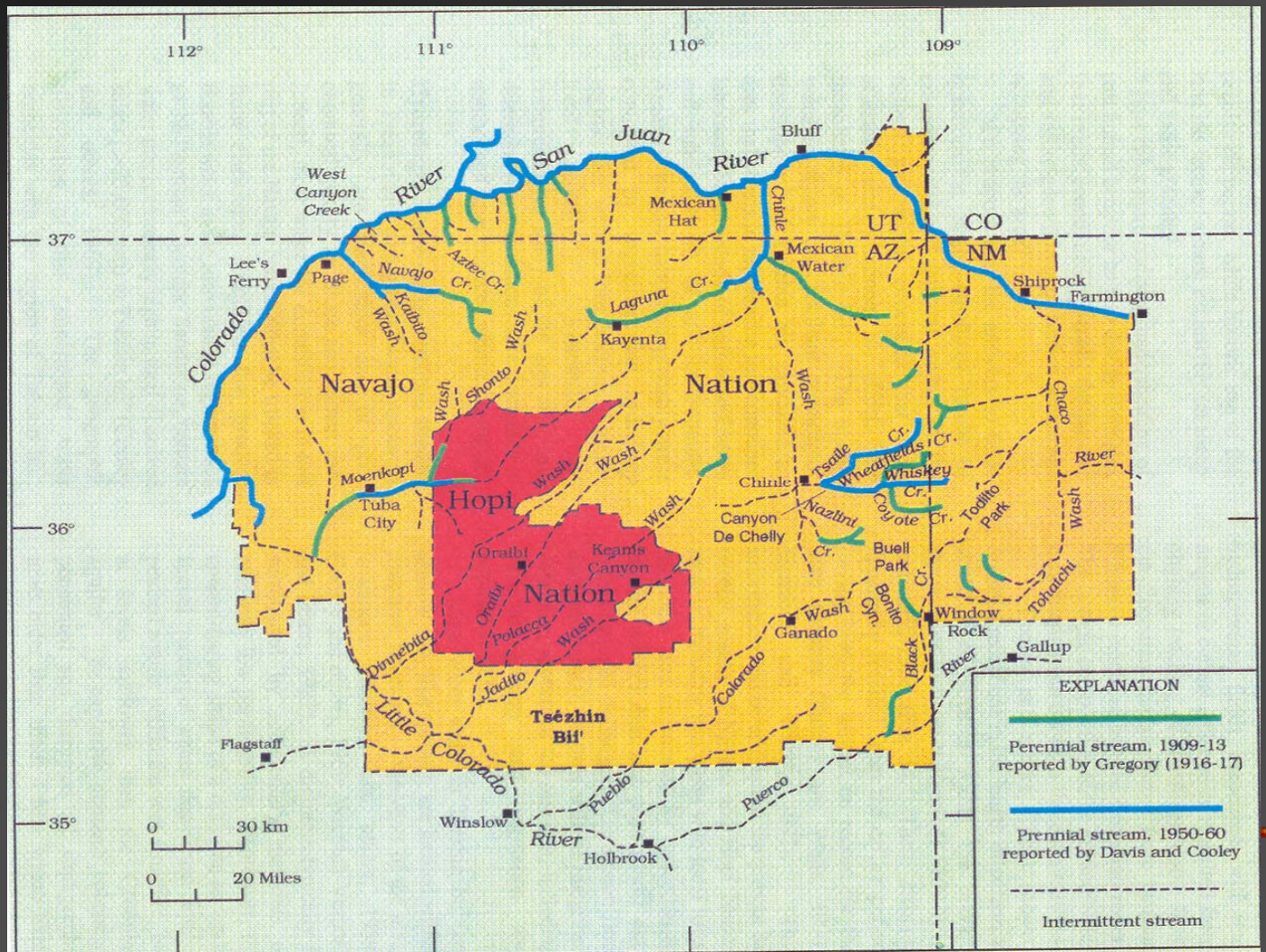
Climate Change

- Models Large in scale
- Storm Intensity likely to increase
- Storm frequency?
- Drought Severity likely to increase
- Less Snow/More Rain
- Thresholds: CO_2 in oceans, Fresh water input

Total Average Snowfall 1931-2004

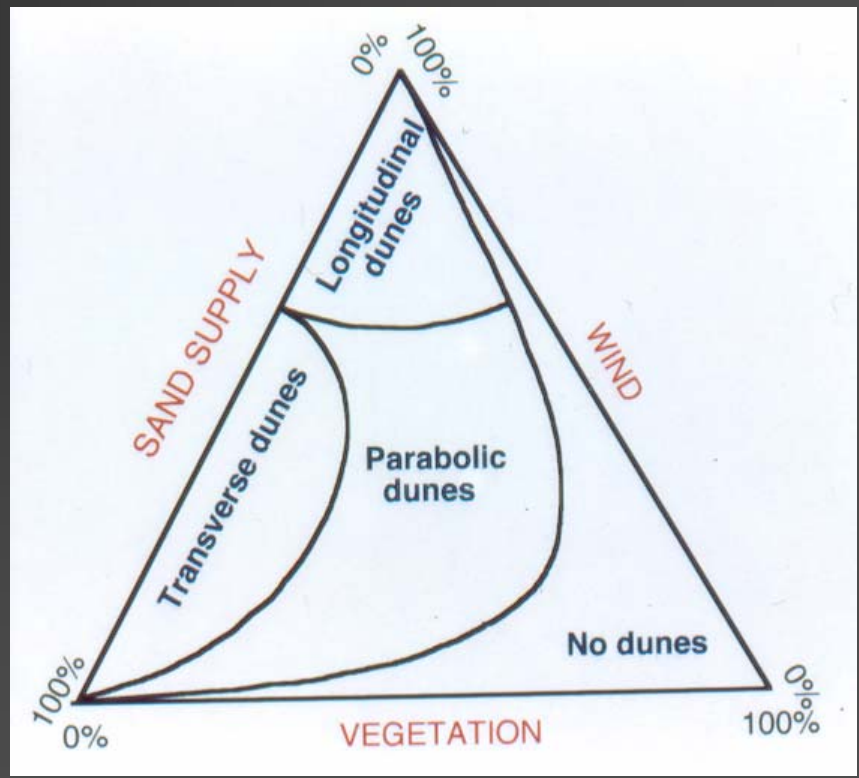


Changes in Streamflow 1910-1960



Factors effecting dune mobility

- Sensitive to climate change
- Wind- Drift Potential
- Sand Supply
- Moisture
- Vegetation



USGS
science for a changing world

Navajo Nation Sand Dunes

Linear Sand Dunes

Barchan (Transverse) Dunes

Parabolic Sand Dunes

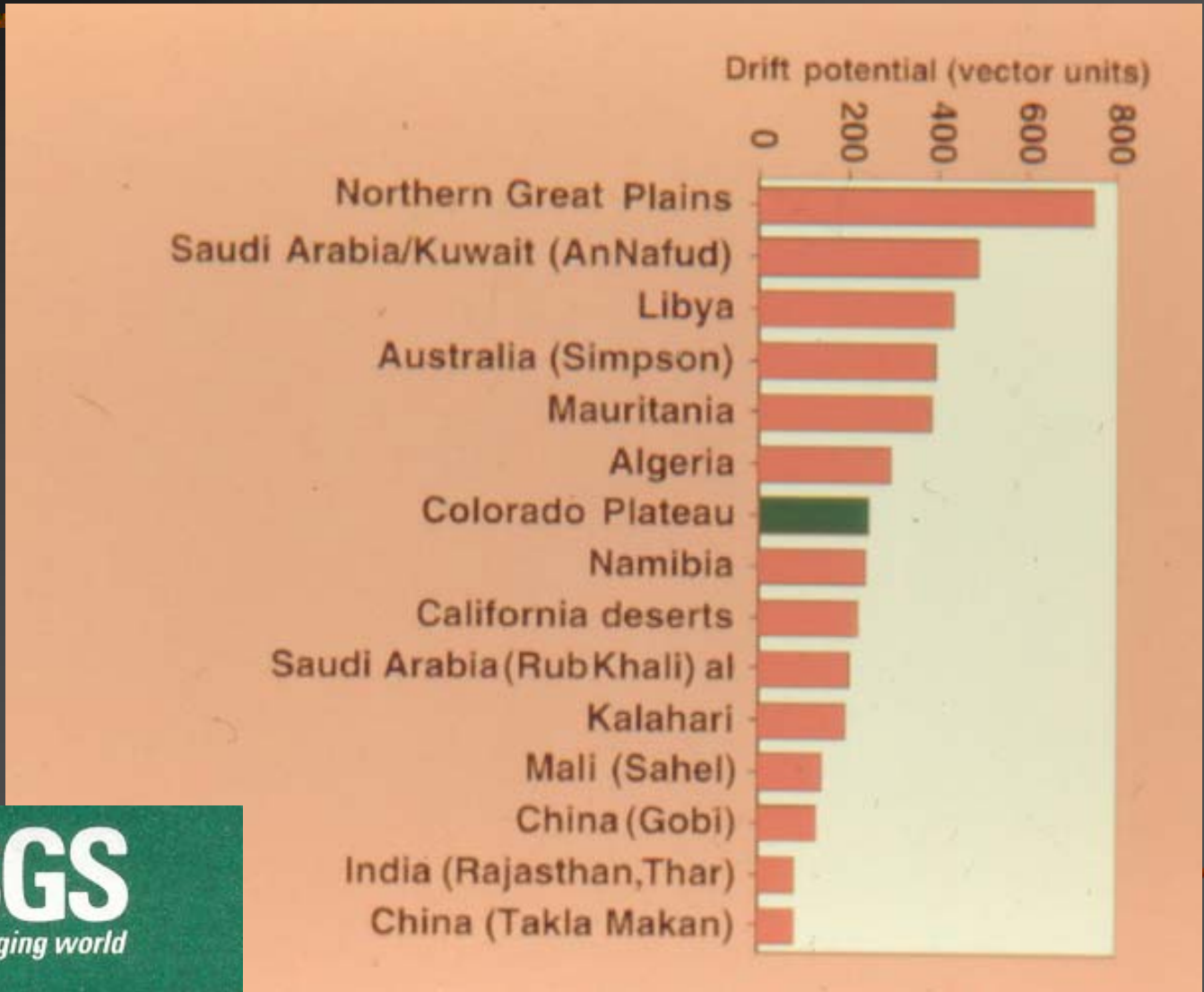
Climatic factors of sand dune mobility

Sand dune mobility (M) = W/(P/PE)

Sand transport potential (W) = Percent of time wind velocities are high enough to transport sand grains

Effective precipitation (P/PE) = Ratio of total precipitation (P) over potential evapotranspiration (PE)

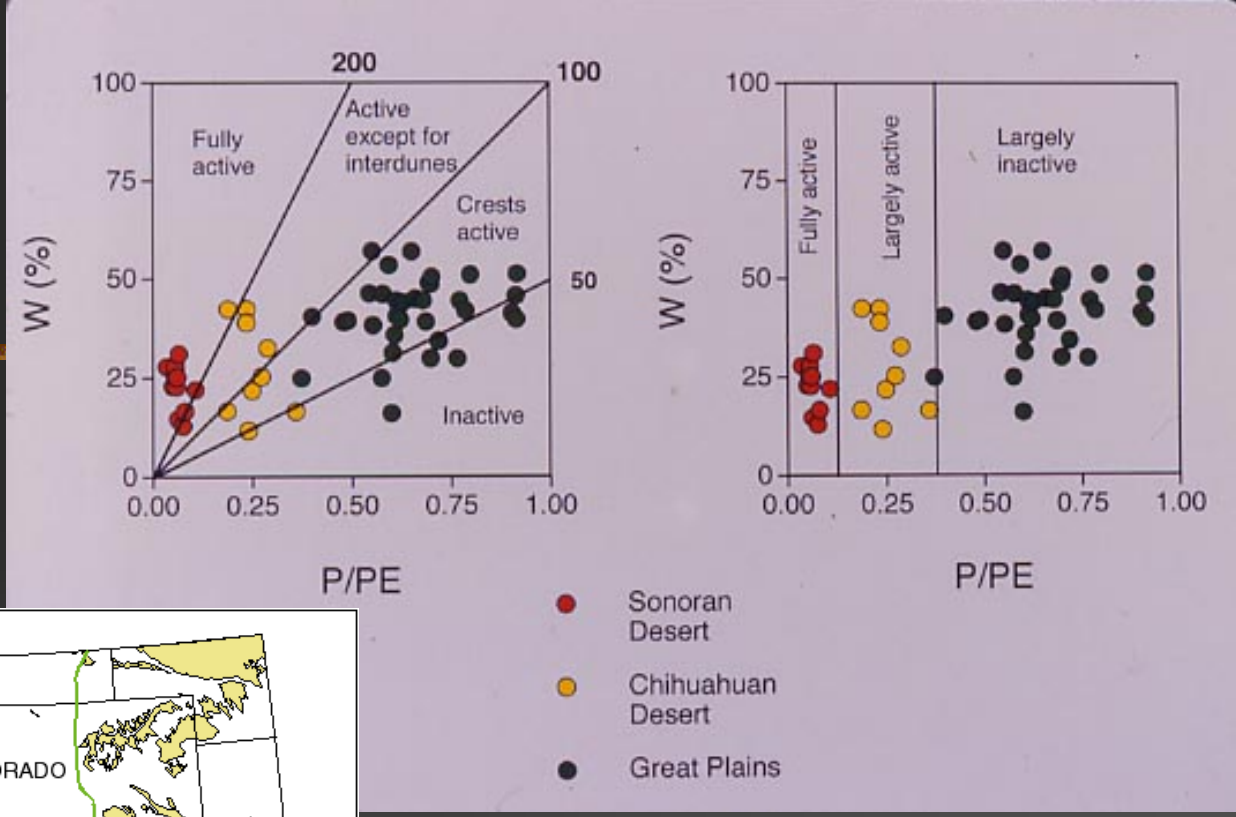
Comparison of Drift Potential

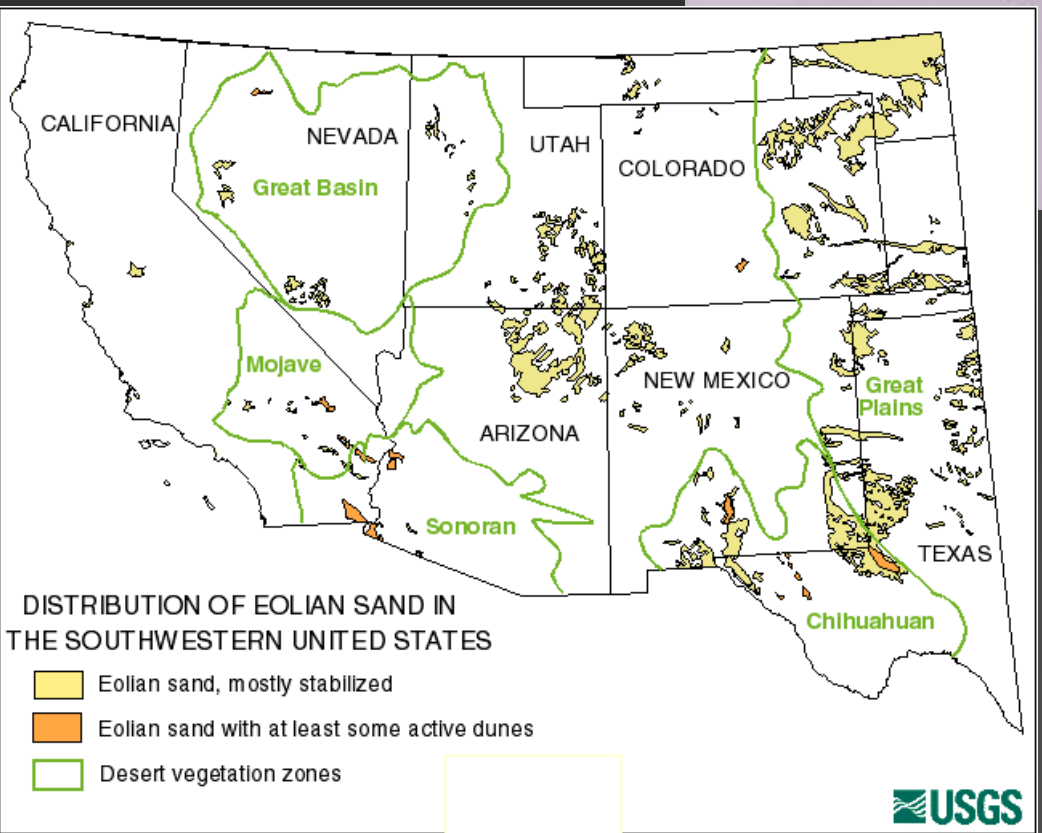


USGS
science for a changing world

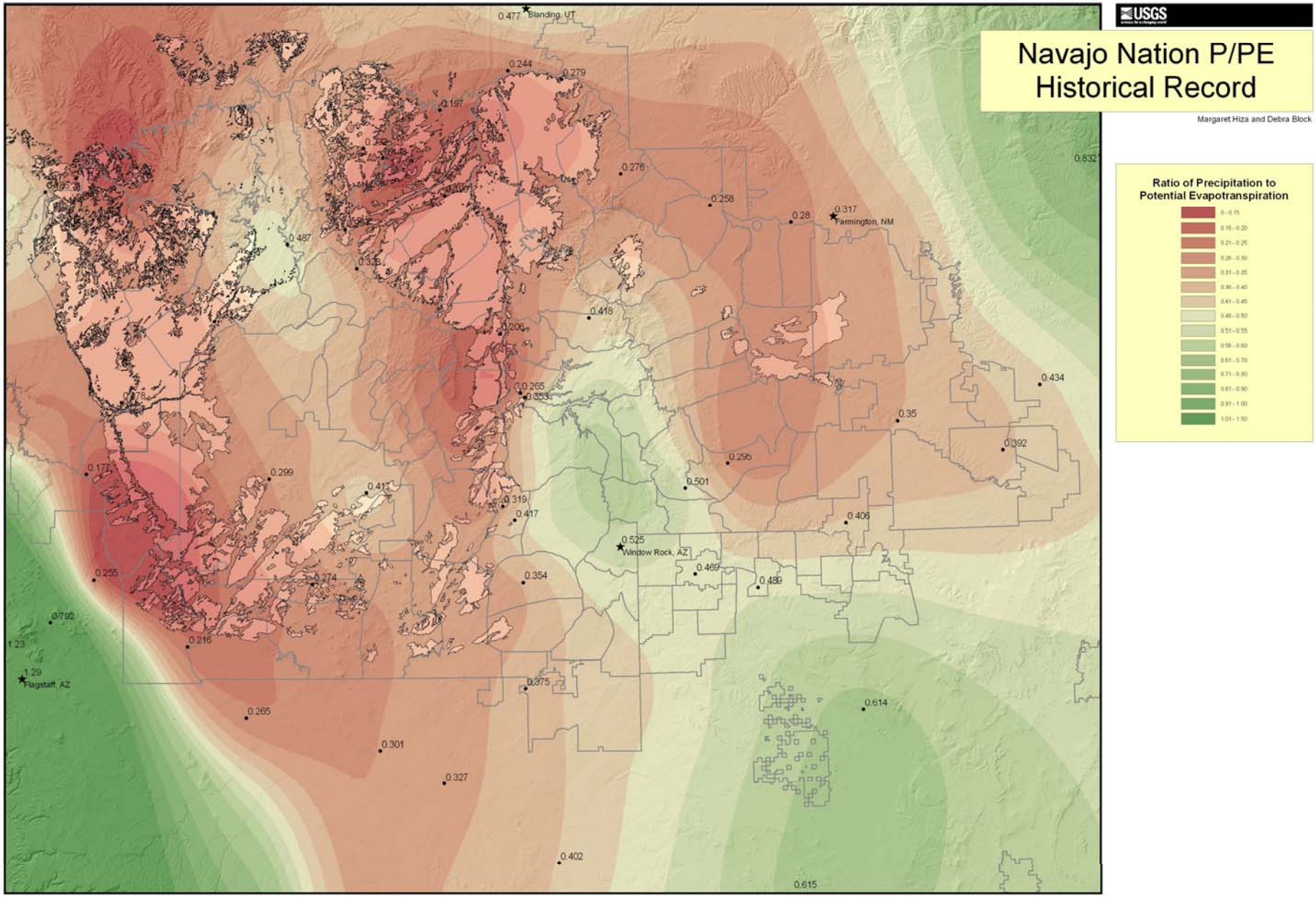
May 20 Windstorm, Red Mesa, NN

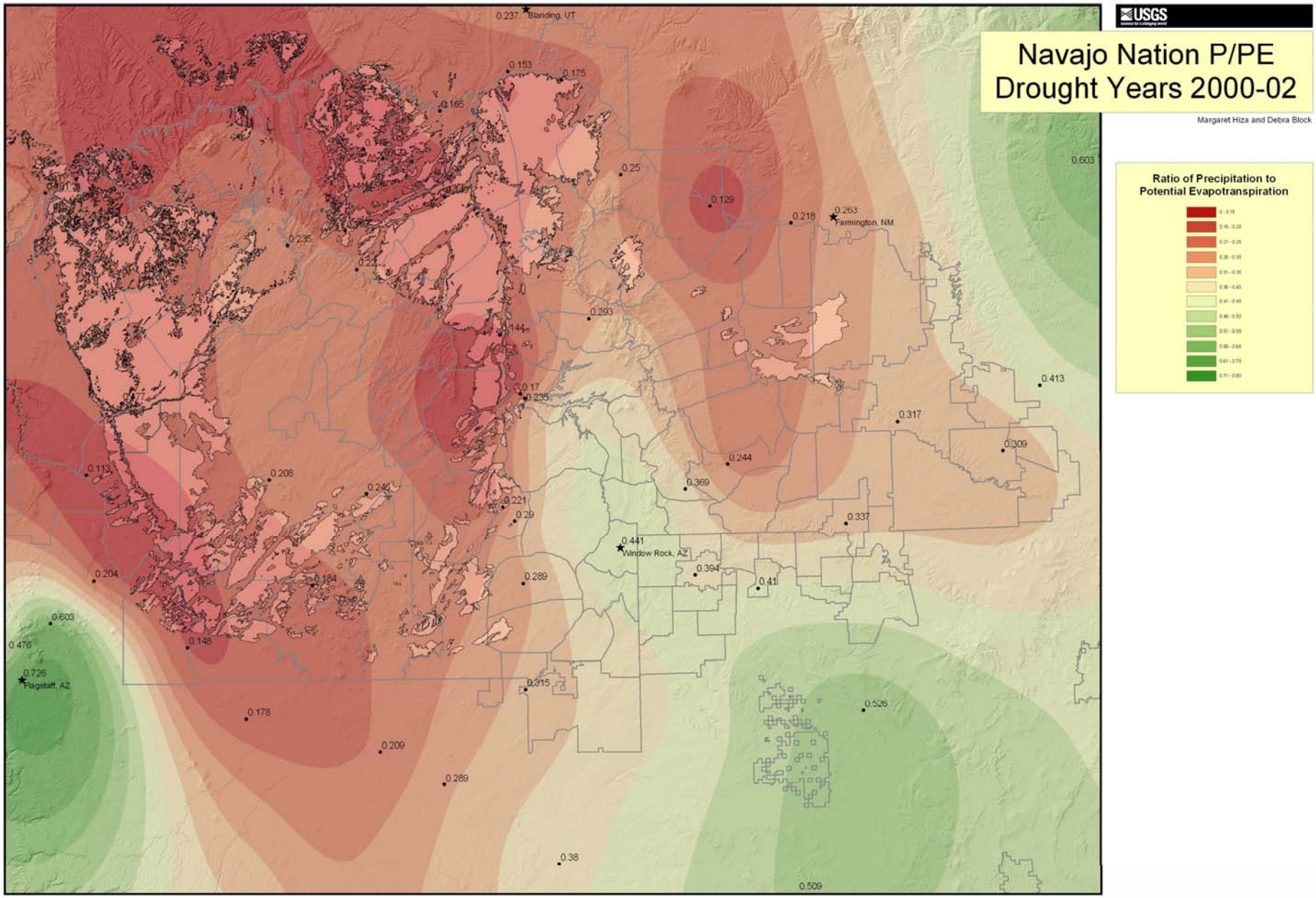
Degree of Stability





USGS
science for a changing world


USGS
Navajo Nation P/PE
Historical Record
Margaret Hiza and Debra Block
Ratio of Precipitation to
Potential Evapotranspiration
0 - 0.15
0.16 - 0.20
0.21 - 0.25
0.26 - 0.30
0.31 - 0.35
0.36 - 0.40
0.41 - 0.45
0.46 - 0.50
0.51 - 0.55
0.56 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.00
1.01 - 1.50
0.477
Blanding, UT
0.244
0.279
0.197
0.276
0.832
0.258
0.28
0.317
Farmington, NM
0.487
0.333
0.418
0.206
0.265
0.353
0.434
0.35
0.392
0.295
0.501
0.177
0.299
0.417
0.319
0.417
0.406
0.525
Window Rock, AZ
0.469
0.489
0.255
0.274
0.354
0.792
1.23
0.216
1.29
Flagstaff, AZ
0.375
0.614
0.265
0.301
0.327
0.402
0.615


USGS
Navajo Nation P/PE
Drought Years 2000-02
Margaret Hiza and Debra Block
Ratio of Precipitation to
Potential Evapotranspiration
0.237 Blanding, UT
0.153
0.175
0.165
0.25
0.603
0.129
0.218
0.263
Farmington, NM
0.235
0.293
0.144
0.17
0.235
0.413
0.317
0.309
0.244
0.369
0.113
0.208
0.246
0.221
0.29
0.337
0.441
Window Rock, AZ
0.394
0.41
0.204
0.184
0.289
0.603
0.476
0.148
0.726
Flagstaff, AZ
0.315
0.526
0.178
0.209
0.289
0.38
0.509

Inactive / Stable Sand Dunes –

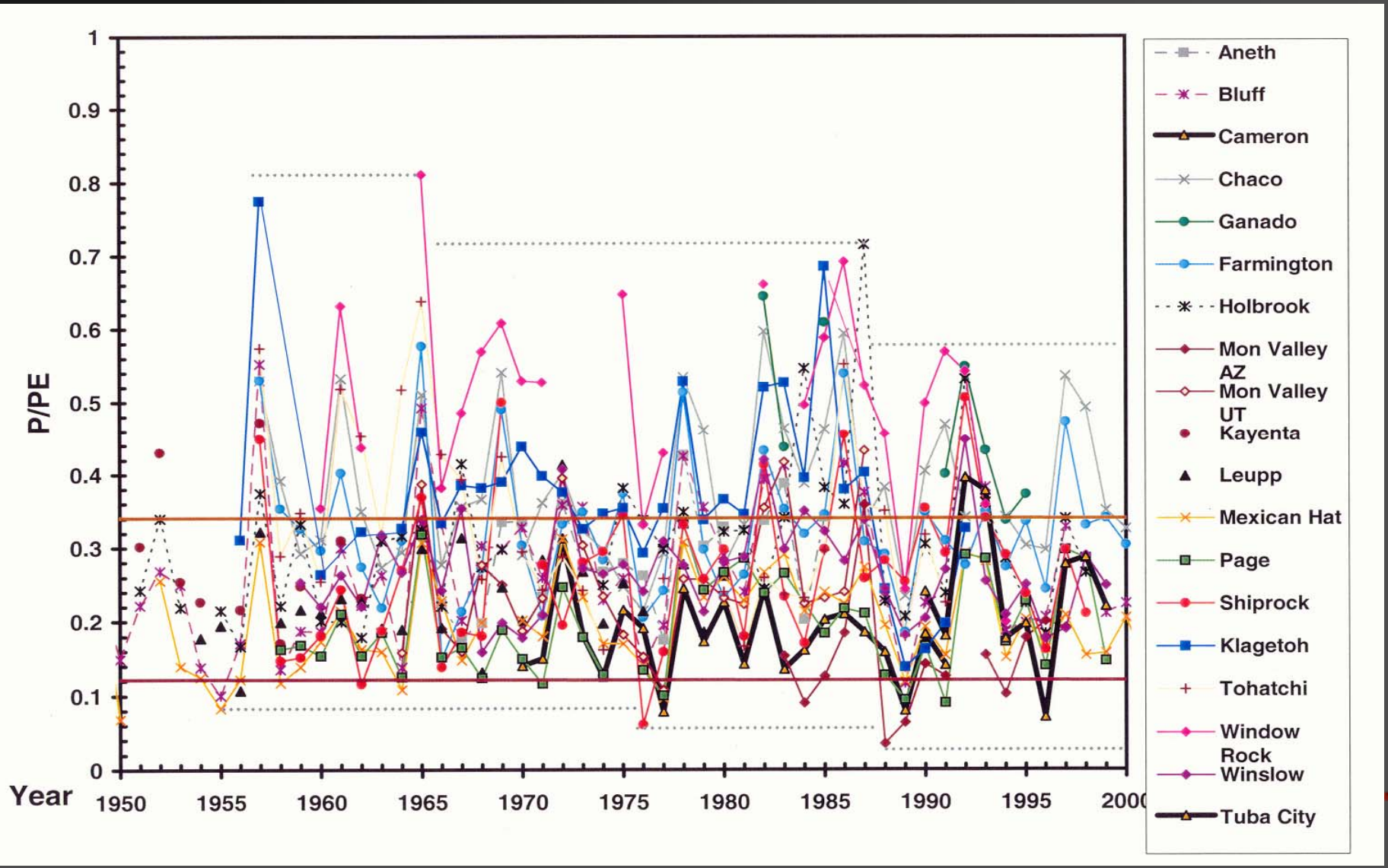
P/PE > 0.30

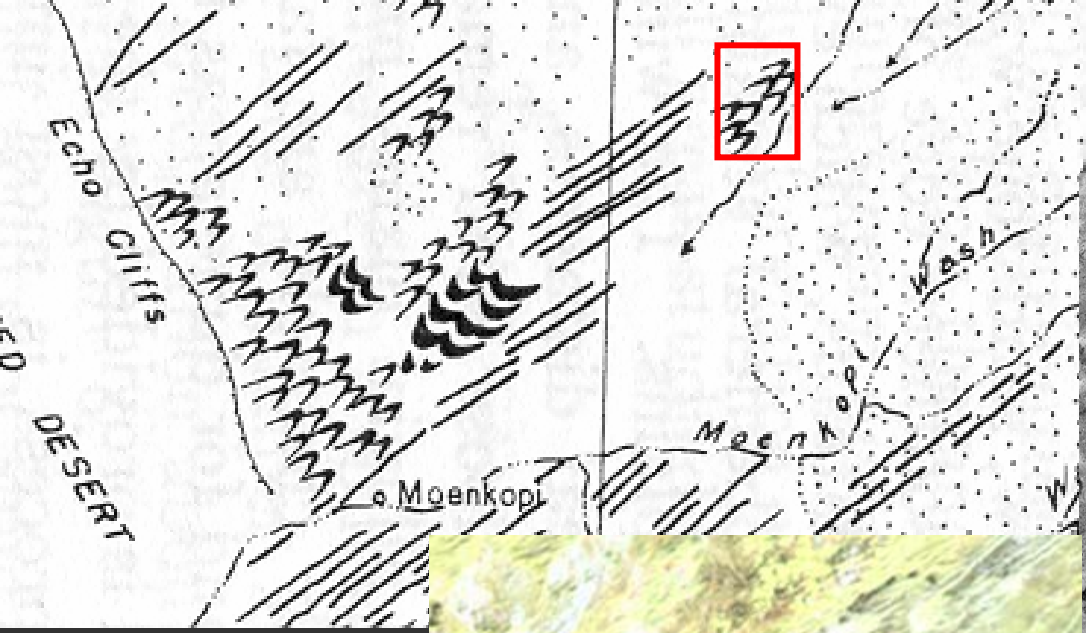
Largely Active Sand Dunes

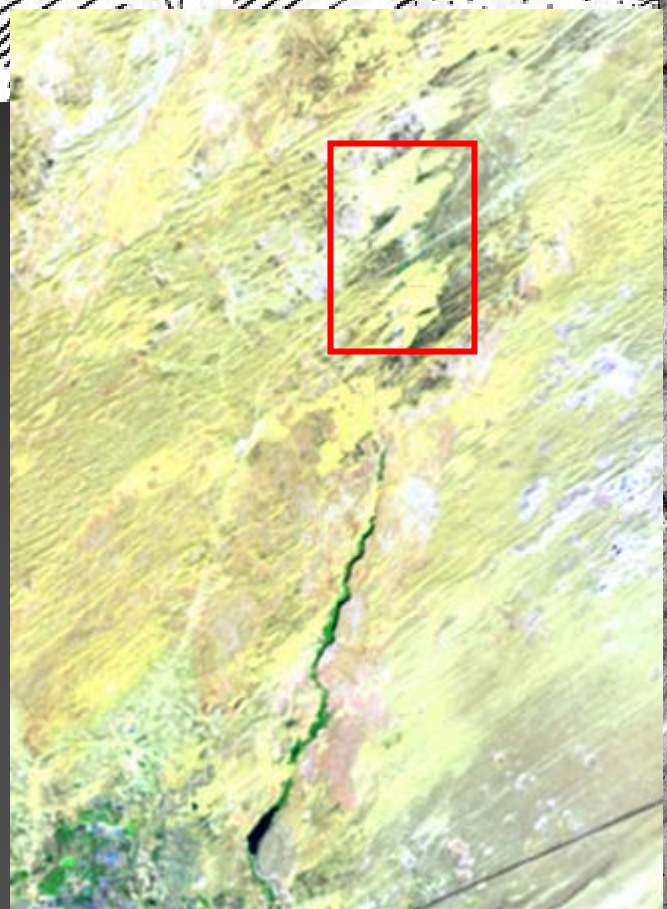
P/PE = 0.30 to 0.125

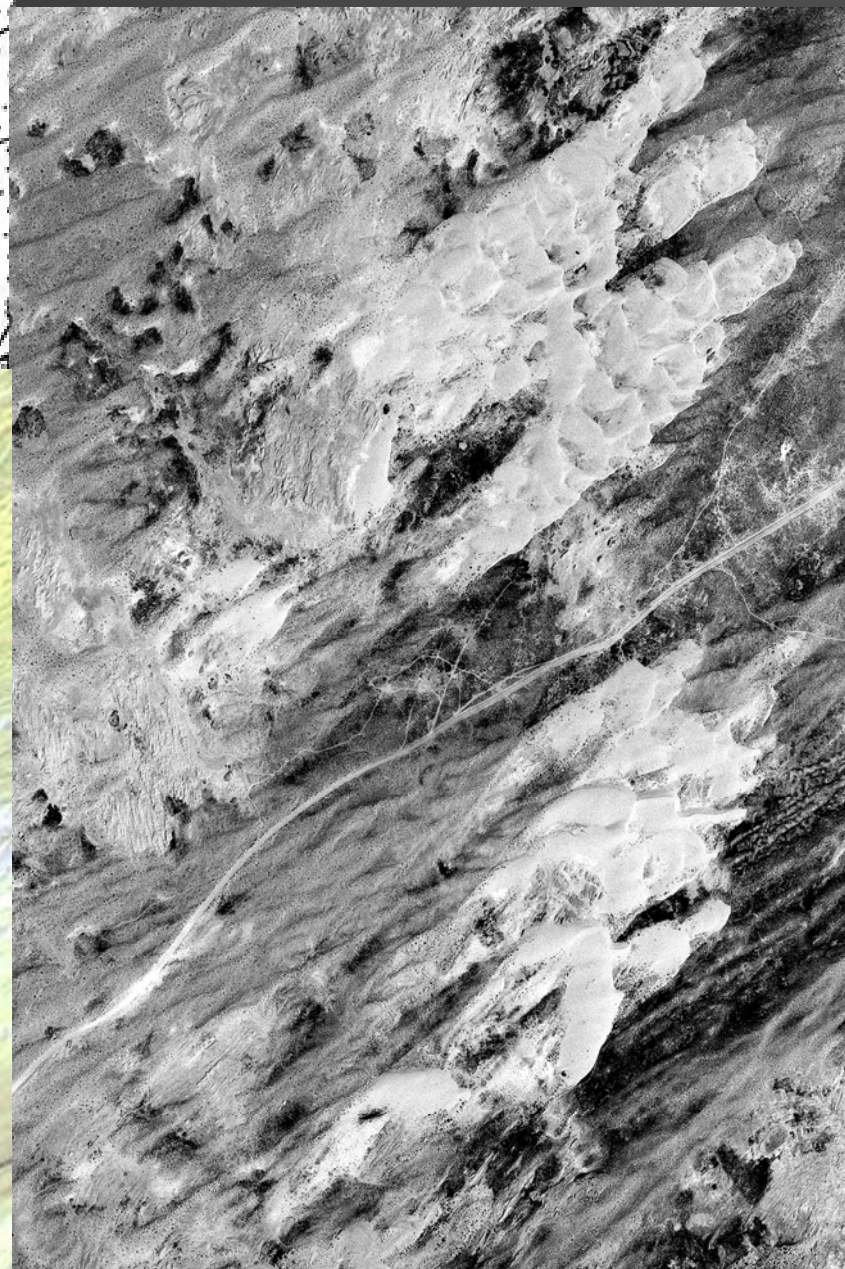
Fully Active Dunes – Tuba City - P/PE<0.125

Known Climatic Variability




Echo Cliffs
DESERT
Moenkopi
Wash
Moenkopi





Processes responsible for changes in the ecosystem

Preliminary Methods

Sand dune mobility indices calculated using Gold Spring climate data 1980 - 2004

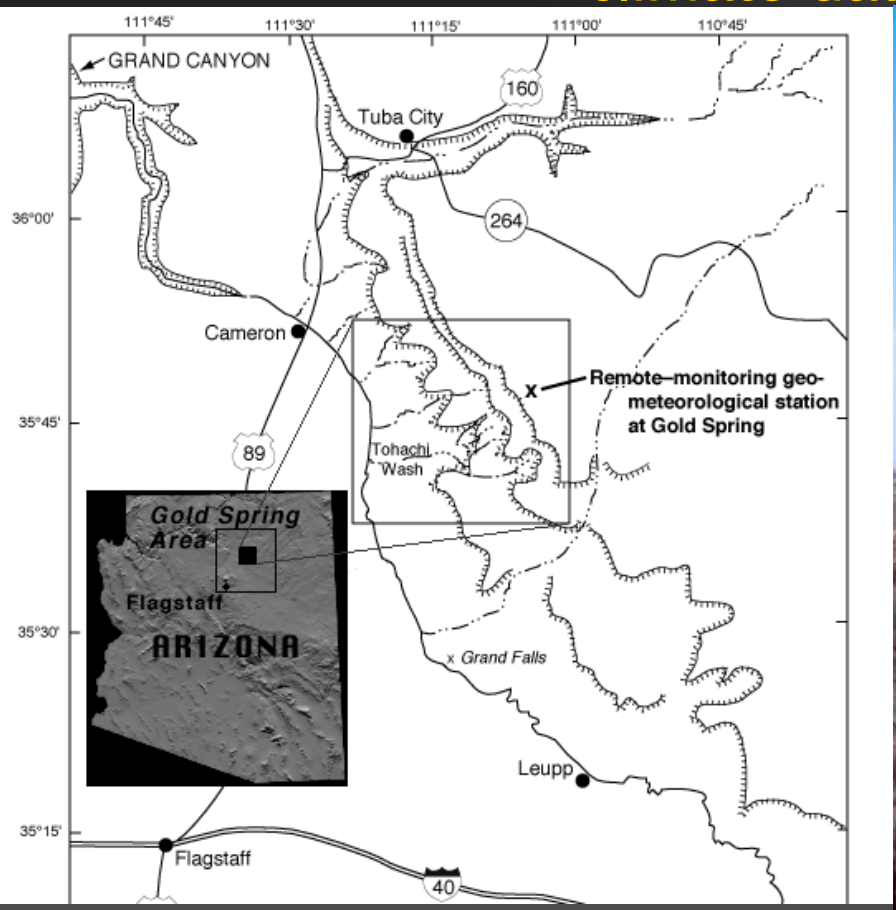


Figure 2. *Left* Map of location of Gold Spring on the Moenkopi Plateau (Billingsley USGS, 1987b) *Right* Photo of the Gold Spring geomet site (Hiza-Redsteer USGS, 2004)

Dune Mobility Index

- **M < 50** abundant vegetation coverage
- **50 < M < 100** mostly stable with bare spots on crests
- **100 < M < 200** vegetation only on the plinth with crests lacking vegetation
- **M > 200** Sand dunes are unstable, vegetation free, and mobile with prevailing winds

Values from past applications (Lancaster, 1988; Muhs & Maat, 1993; Lancaster & Helm, 2000)

Preliminary Results

Climatic sand dune mobility index issues

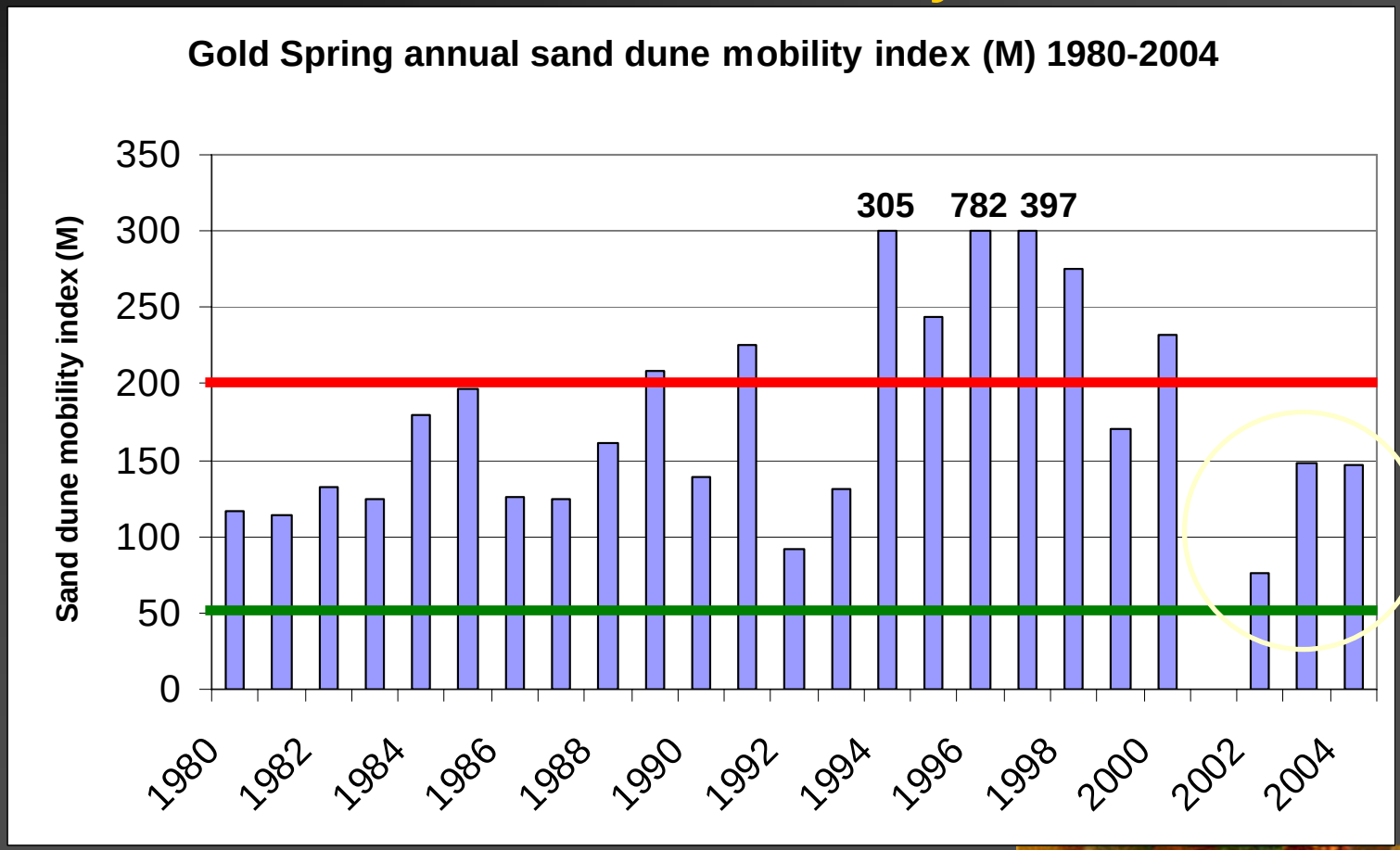


Figure 3. Annual sand dune mobility indices at Gold Spring 1980-2004 (Thornbrugh, 2005)

About NDVI

- Normalized Difference Vegetation Index (NDVI)
  - Indicates of surface vegetation productivity from AVHRR Satellite data
  - Applicable to various vegetation bio-types
  - Used to assess vegetation response to precipitation in US Great Plains, Chihuahuan Desert, and Kalahari of Botswana
  - Very little past research on precipitation & NDVI relationships for Colorado Plateau

Coalmine Mesa monthly NDVI 1989 - 2005

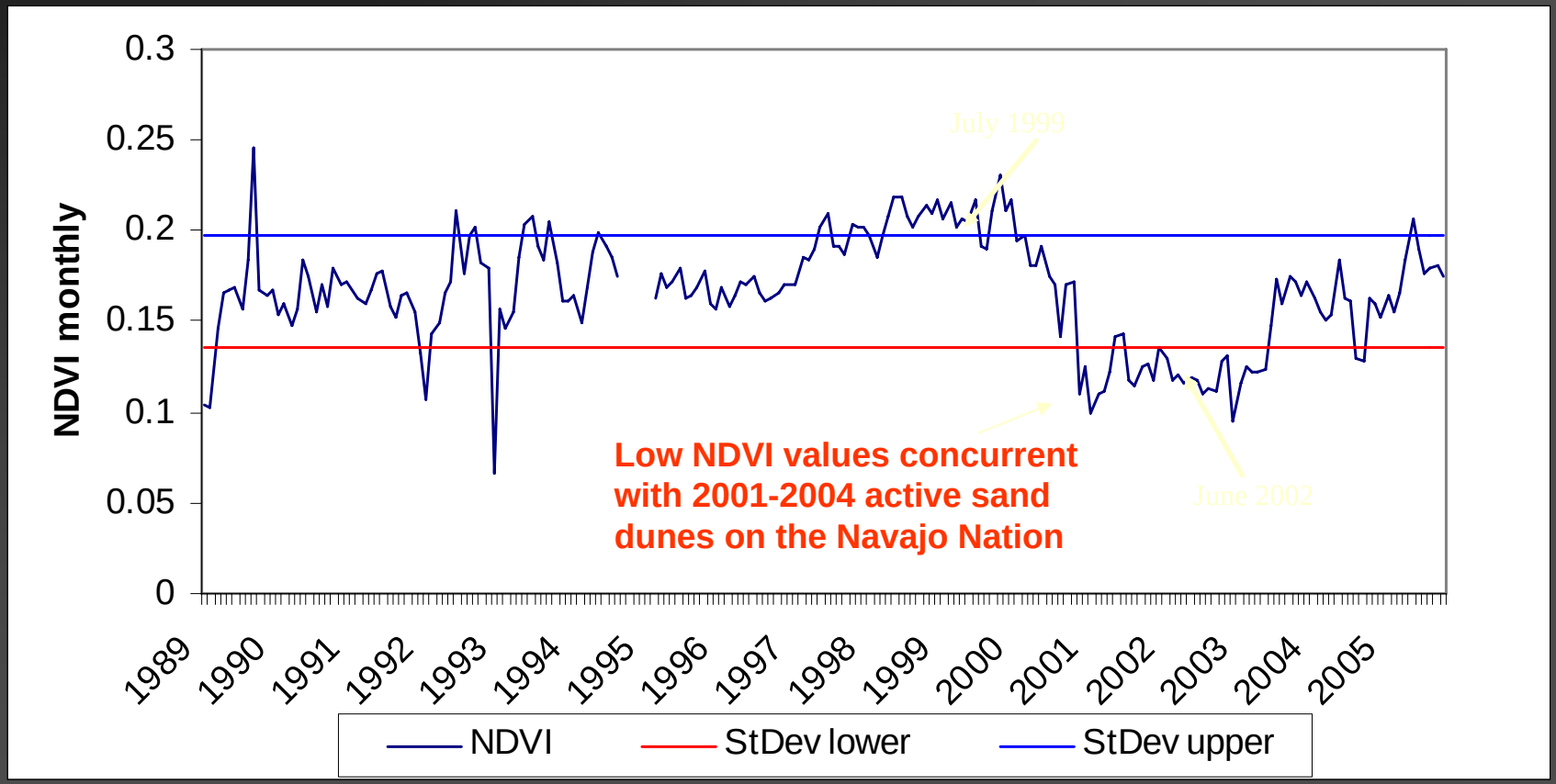
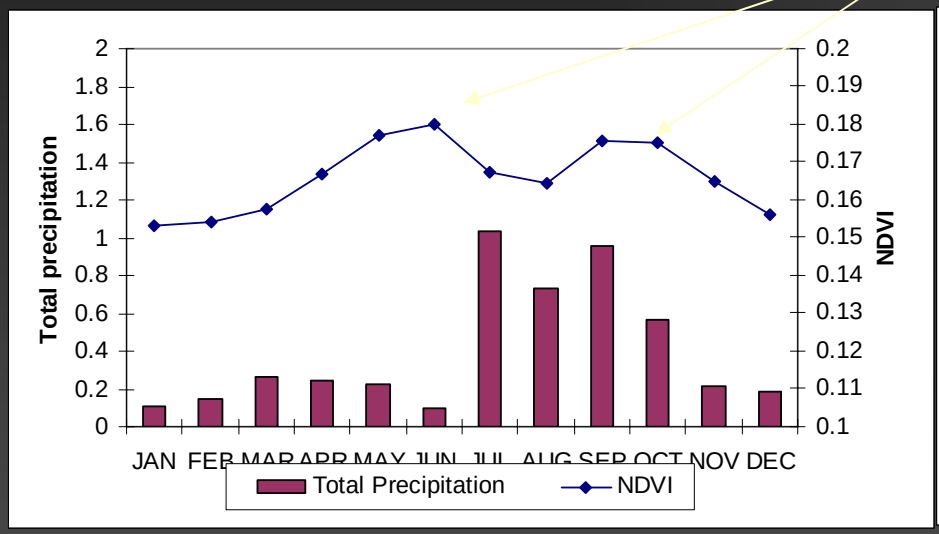


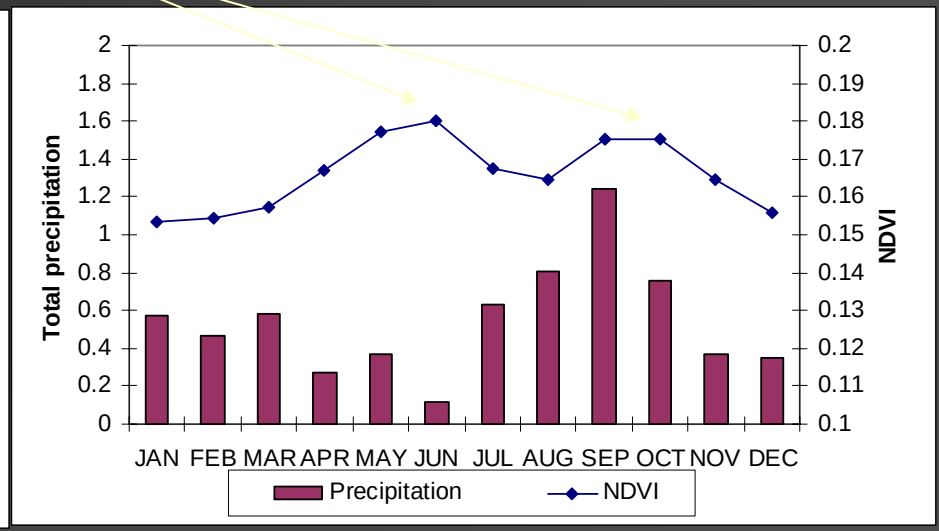
Figure 6. Monthly time series of NDVI over Coalmine Mesa 1989-2005 (Thornbrugh, 2005)

Coalmine Mesa annual NDVI distribution

Mean maximum NDVI vegetation productivity

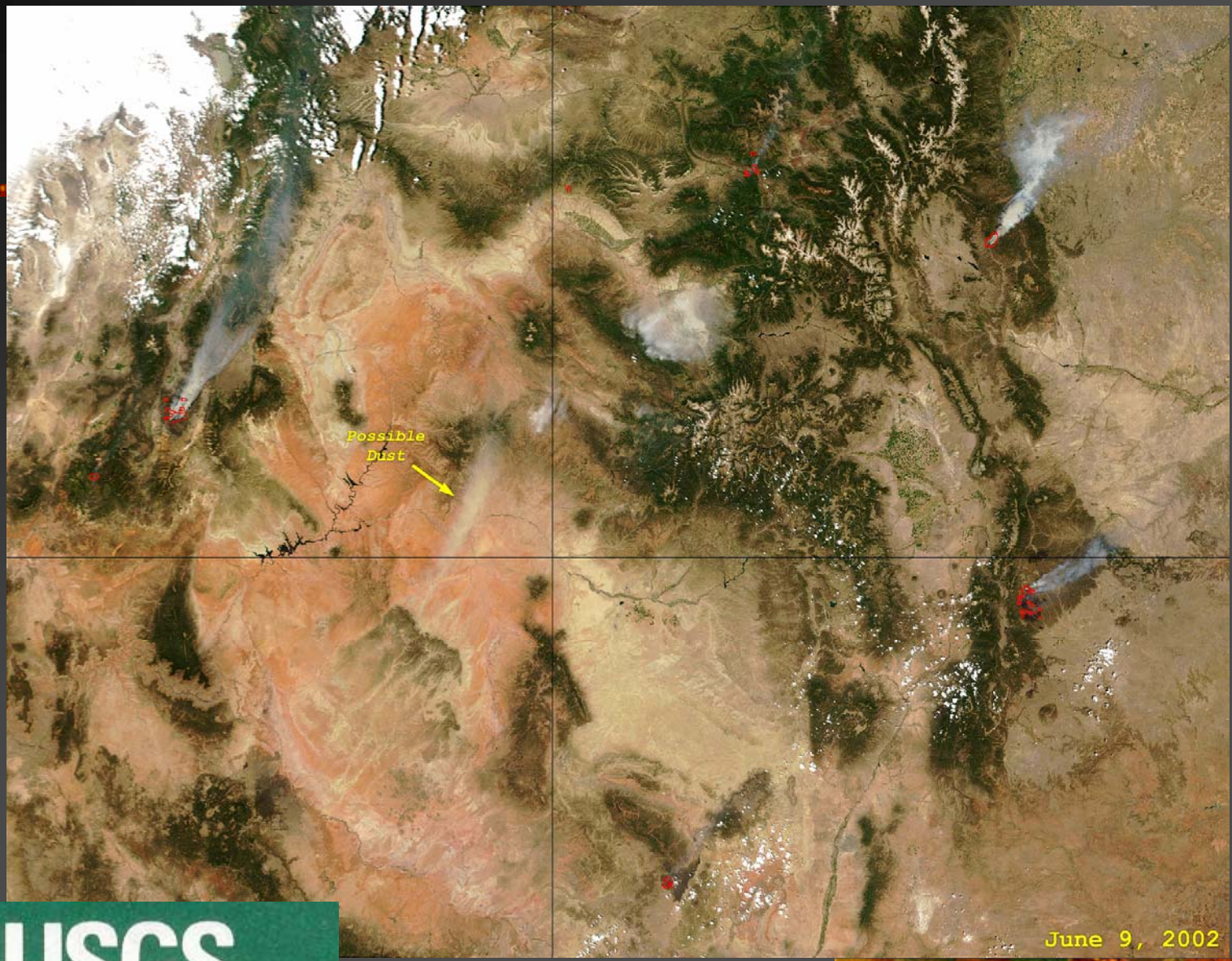


Gold Spring

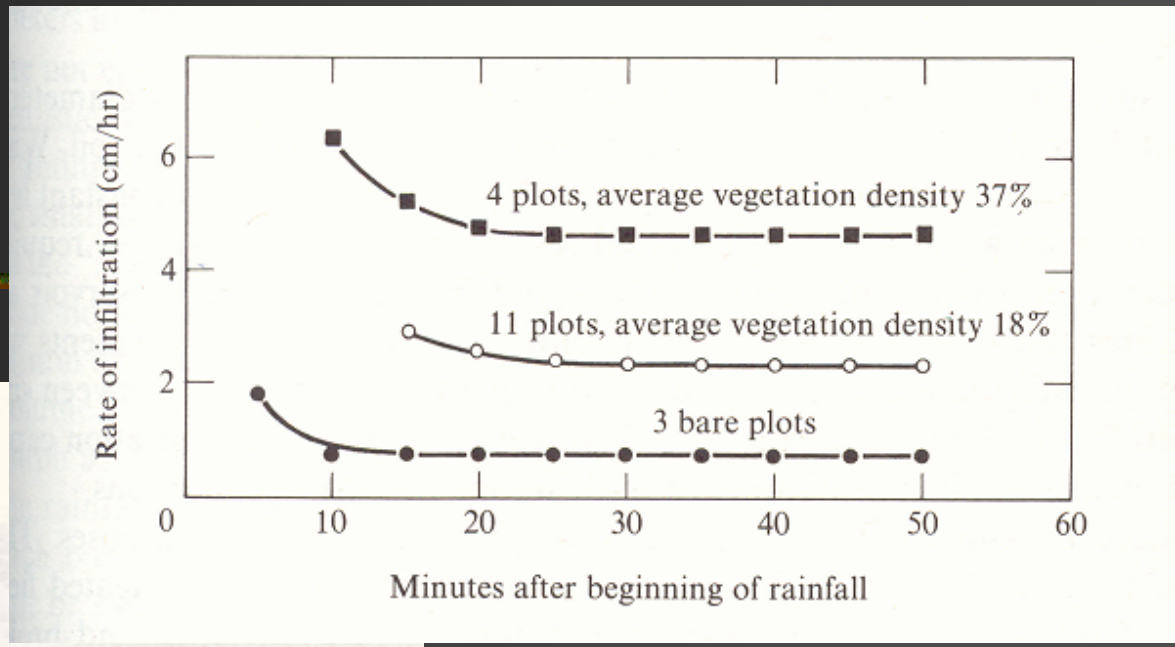


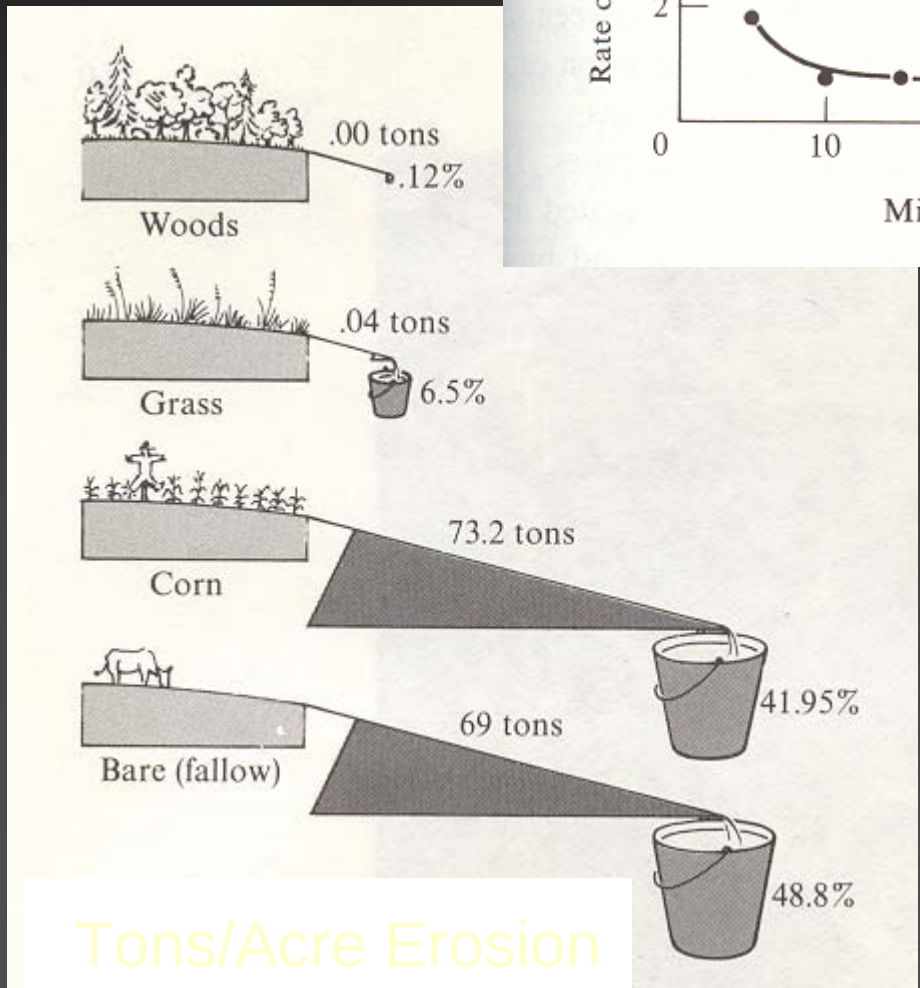
Tuba City

Hypothesis: Increasing NDVI in the spring could be related to increasing temperature and increasing NDVI in the late summer could be related to increasing total precipitation.



USGS
science for a changing world





Tons/Acre Erosion

Kayenta AZ, September 2003

Kayenta, AZ 2004

Dune mobility & destabilization

- ***Land Use***
- ***Invasive Species***
- ***Drought***
- ***Changes in sediment availability***